

EXECUTIVE SUMMARY

The interaction between soil and hydrology, i.e. hydropedology, is an important field of research that has been neglected for a long time. Partly because of the prevailing ever increasing stress on the natural environment, it has recently become increasingly important to elucidate and quantify the interaction between water and soil, not only directly with regard to hydrological studies but also with regard to wetland ecosystems; non-wetland ecosystems; the agro-ecosystem (crop production and food security); carbon sequestration; forestry; catchment management; efficient water use; environmental degradation involving soil hydrology, i.e. pollution studies.

Achieving the aims of this study will provide information that will be useful in all these natural resource problem areas that are currently becoming increasingly important.

The aims of the project were:

1 To develop advanced soil survey techniques, with which soil survey information suitable for hydrological research and modelling can be generated at reasonable cost.

2 To optimise the intensity of soil survey information that contributes effectively to hydrological modelling.

3 To improve the interpretation of soil information in ACRU (a hydrological model using detail soil information).

4 To improve the contribution of hydropedology to the hydrology of catchments by quantifying the soil water regime of selected hydrologically important soils of South Africa.

5 To improve the understanding of the impact of land-use change on the soil water regime and therefore on the hydrology of the Weatherleyey catchment.

A detailed literature review on three aspects of hydropedology is presented. The subjects covered are: international advances in hydropedology; application of hydropedology in hydrological research; knowledge contributions. The procedure adopted to achieve the first four aims was carried out on five catchments, viz. Weatherleyey, Cathedral Peak VI, Two Streams, Craigieburn and Bedford. The soil survey techniques used aimed at identifying modal hillslopes and the main soils in each of the hillslopes. For Weatherleyey the previously completed soil survey results (Roberts *et al.*, 1996) were used. Preliminary office studies of each catchment were conducted using land type data (1:250 000), 1:50 000 maps, Google images, application of 3D Mapper technology and study of relevant literature. Field work consisted of making effective soil survey transects along which the main soils were identified and samples taken for analysis. The results obtained enabled the description of the modal hillslopes in each catchment and their component pedosequences.

For the main hillslopes in each catchment conceptual flowpath models were formulated, depending on the soil distribution patterns, and presented in diagrammatic form. The relevant hydrological characteristics of the main soils were described and were quantified

where possible. Important hydrological characteristics of the soils of Weatherleyey are described in detail in van Huyssteen *et al.* (2005). In the study described here, soils of the following forms were identified during the soil surveys: Champagne, Tukulu, Longlands, Kroonstad, Katspruit, Mispah, Augrabies, Swartland, Valsrivier, Oakleaf, Glenrosa, Dundee, Nomanci, Kranskop, Cartef. Based on their hydrological characteristics these soils were subdivided into three hydrological soil groups named recharge, interflow and saturation excess soils. The predicted roles that the important soils played in the hillslope hydrological processes in each catchment were identified and described by means of conceptual hillslope hydrological response models. As far as possible the hydrological properties of individual soils and their diagnostic horizons were also quantified.

The following procedure was adopted to specifically address aim (2), i.e. to test the influence of improved soil data on the performance of hydrological models. For the catchments Weatherleyey, Two Streams, Craigieburn and Bedford soil information at two levels was presented, i.e. firstly, land type data, and secondly the current soil survey results. The models tested were ACRU on Weatherleyey and Craigieburn, Pitman on Bedford and ACRU, SWAT and WAVES on Two Streams. The exercise produced mixed results. A logical hypothesis is that better soil data should produce better simulations by the hydrological models. It needs to be kept in mind however, that this hypothesis can only prove to be correct if the hydrological models used can use any soil data, and particularly the improved soil data, effectively. The results indicate that both SWAT and WAVES are unable to do this. ACRU gave mixed results and the reasons for this are unclear. As measured runoff data is not available for Bedford, it is not possible to evaluate the response of the Pitman model to improved soil data in a reliable way. An important result of this exercise is that all the models responded to differences in soil data inputs, i.e. they recognise that the soils that occur in a catchment influence the hydrograph.

The influence of land use change from grassland to afforestation at selected sites in the Weatherleyey catchment has been quantified. Soil water regime measurements show that as expected, the trees dry the soil out to a greater extent than the grassland did, i.e. the trees use more water; that most of this additional extraction is from the deep soil layers; that the surface soil under the trees is generally wetter than under grassland, presumably due to the influence of decreased evaporation loss promoted by the layer of litter and increased shading; that the soil water regime in a profile monitored in the marsh has become wetter after afforestation in the adjacent hillslope, presumably because of a decrease in overland flow due to denser hillslope vegetation promoting increased deep percolation of water into the lower vadose zone feeding the marsh. It is considered that the aims of the project have been satisfactorily achieved; that all members of the research team have experienced major intellectual capacity growth; and furthermore, that a useful preliminary contribution has been made to the hydrology of South African soils and hillslopes, an important subject still in its infancy and therefore calling for continued intensive study.